ORegen*

Waste Heat Recovery System for GE and other OEM Gas Turbines

Benefits

- ■■■ **Increased production**
- ■■■ **Higher efficiency**
- ■■■ **Compliance with environmental regulations**
- □□□ Availability and Reliability
- □□□ Life extension

Addressing environmental problems is becoming an important initiative throughout the world. The reduction of CO_2 emissions is a key element in the path toward lowering the human contribution to climate change.
Many industrial processes generate waste energy that passes out of plant stacks into the atmosphere and is lost.
Energy recovered from waste heat streams could supply part or all of the electric power required by a plant, at no additional cost.
Therefore, heat recovery offers a great opportunity to conserve by productively using this waste energy, to reduce overall plant energy consumption and simultaneously decrease CO_2 emissions.

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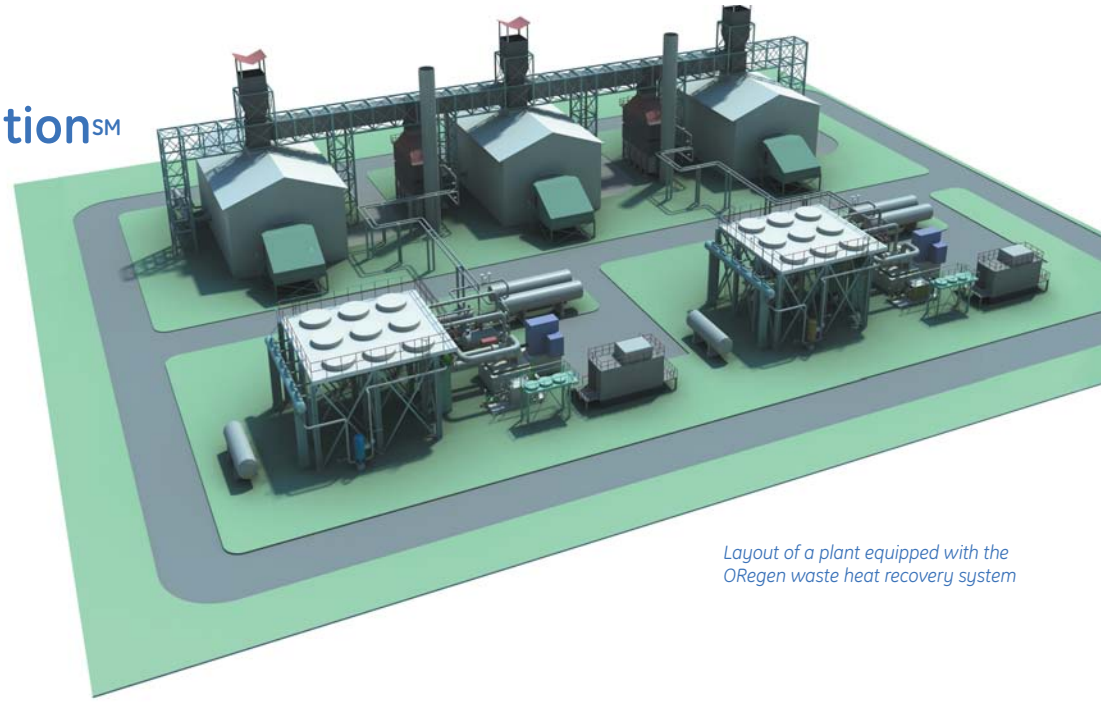
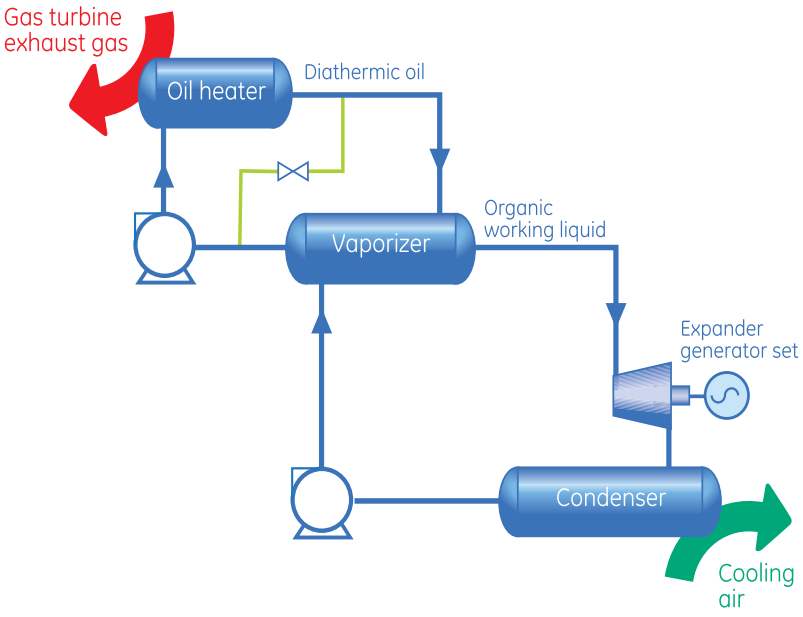


Layout of a plant equipped with the ORegen waste heat recovery system

What it is

Power generation with zero additional emissions

ORegen is a thermodynamic superheat cycle that recovers waste heat from gas turbine exhaust and converts it into electric energy. The thermodynamic cycle is based on an Organic Rankine Cycle (ORC). Heat from the turbine exhaust is transferred to a closed diathermic oil loop, which is used to heat an organic fluid loop. This lower temperature heat is then converted into useful work that can generate electricity. The ORC works with a hydrocarbon fluid in place of water. The system is similar to a conventional steam bottoming cycle except for the organic fluid that drives a turboexpander that in turn drives the generator. The diathermic oil and the organic fluid allow low temperature heat sources to be exploited efficiently to produce electricity over a wide range of power output, from a few MW up to 16 MW per unit.



How it works

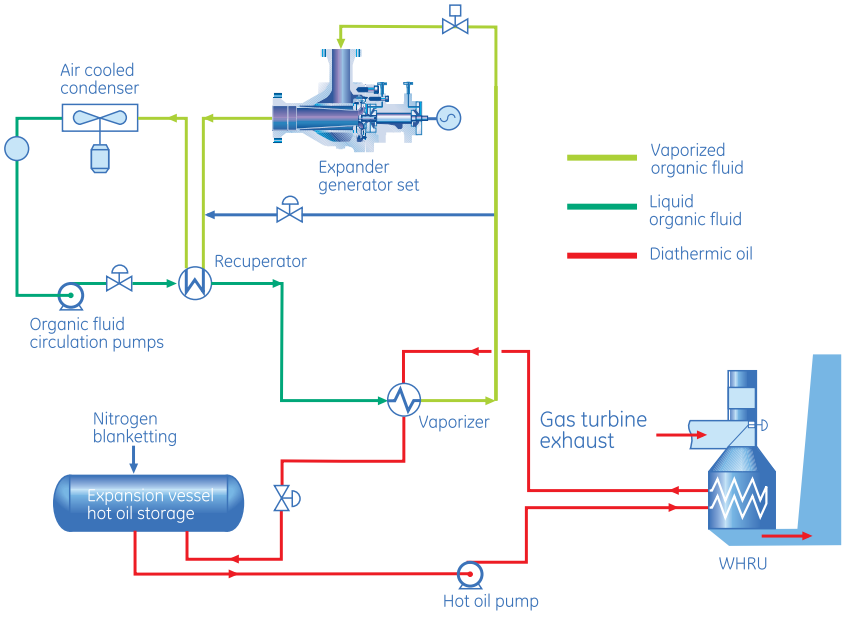
Closed loop system

The organic working fluid is vaporized and pressurized in the evaporator by the application of heat taken from the gas turbine exhaust stream. Then, the vapor expands in the turboexpander and is condensed using air-cooled heat exchangers at ambient conditions. The condensate is pumped back to the evaporator, thus closing the thermodynamic cycle. The heating and cooling sources are not in direct contact with the working fluid, nor with the expander. For higher temperature applications, a high temperature thermal oil is used as the heat carrier and a regenerator is added to further improve the cycle performance.

The selection of the working fluid is key in a Rankine Cycle.

The features are:

- Low freezing point and high temperature stability
- High heat of vaporization and density
- Low environmental impact
- No additional EHS considerations
- Readily available at low cost



How it works

ORegen vs Steam Cycle

Features	ORegen	Standard Steam Combined Cycle
Water free	***	*
Low maintenance	***	*
Power flexibility	***	*
Low investment	**	*
Plant simplicity	***	*
Reduced footprint	***	*
No replenishment of working fluid	***	*
Unmanned capability	***	*
Additional output	**	***

Expected ORegen Power Output for Mechanical Drive and Power Generation Gas Turbines

Gas Turbine Model	Gas Turbine Power (KW)	Exhaust Flow (Kg/sec)	Exhaust Temp (°C)	Gas Turbine Efficiency (%)	ORegen Gross Output (MWe)	System Efficiency (%)
PGT25 (*)	23,261	68.9	525	37.7	**6.9**	48.9
PGT25+ (*)	31,364	84.3	500	41.1	**7.9**	51.5
PGT25+ G4 (*)	33,973	89.0	510	41.1	**8.6**	51.5
MS5001 (*)	26,830	125.2	483	28.4	**11.3**	40.4
MS5002C (*)	28,340	124.3	517	28.8	**12.4**	41.4
MS5002D (*)	32,580	141.4	509	29.4	**13.8**	41.9
MS6001B (*)	43,530	145.0	544	33.3	**15.6**	45.2
LM6000 (**)	43,397	125.6	454	41.7	**9.7**	51.1

Reference data @ISO Conditions, 100% GT Turbine load, one to one configuration
(*) Values at gas turbine shaft
(**) Values at generator terminals for LM6000PC coupled to 60 Hz generator

Scope of Supply

The basic scope of supply includes the following:

- Organic fluid system
- Diathermic oil system
- Boilers and heat exchangers
- Turboexpander genset
- Piping and BOP components
- Air or water cooler

Waste Heat Recovery Unit

Organic Fluid System

GE imagination at work

GE Oil & Gas

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